

This manuscript describes the implementation of a terrestrial phosphorus cycle into the land surface model ORCHIDEE. The authors used the fertilization experiments at two sites along the Hawaii chronosequence to evaluate the nutrient representation in the NP-enabled ORCHIDEE. With the increasing realization of the important role of phosphorus cycle in affecting global carbon cycle, this work is timely. Overall the manuscript is well written as a modelling paper. I just have some suggestions and edits as shown below.

#### General comments:

- 1) Introduction a bit too short – maybe it is sufficient for a modeling paper on GMDD but I think a bit more on how this representation of P cycle is different from other P models will position this work better
- 2) I would like to see a model diagram that shows the phosphorus pools and fluxes and maybe with major phosphorus processes. Although those have been described here and there in the manuscript, a diagram will help the reader to better understand the model and link them with many equations in the text.
- 3) Figure 2 seems a repetition of a subcomponent of Figure 1 and can be removed,
- 4) Labile phosphorus was used in the text to describe both labile phosphorus in plant and soils and it can be confusing sometimes.

#### Minor comments:

Page 2, line 10: change “rise” to “rises”

Page 2, lines 22-25: acronyms were used ( Ama, Euc, IMB, AFE.....), not sure what they are and no references for them

Page 3, line 20: should be “except for”

Page 3, eq. 2: is this eq. complete?

Page 4, lines 12-14: this is not clear to me

Page 5, eq. 3:  $u_{max}$  – maximum root uptake capacity and  $v_{max}$  -> maximum uptake capacity of roots. Seems the same thing to me – need to be better defined. Also, I could not get the units on the two sides of the eq. consistent

Page 6, line 22: “ the actual value of  $f_{PNplant}$  may be higher than 1” – what is the implication for plant P uptake? Is it realistic?

Page 8, eq 12: how C growth is scaled? Photosynthesis or NPP? Equation will be helpful here

Page 9, section 2.1.3: This section is very general – not P specific. Could be removed or make it more focusing dynamics in litter and soil organic matter

Page 9, line 27: the turnover time of phosphorus is set to half the turnover times used for biological mineralization of organic matter – what is based on? Or Any reference?

Page 10, line 2: from primary minerals

Page 11, eq 27: should it be the other way around? When diffusion flux is greater than uptake, there is no change in the difference in labile P between root surface and the surrounding

Page 12, section 2.1.7: this section only deals with N fixation – can be put in appendix if needed

Page 12, section 2.1.8:

Page 19, line 6: should be “due to”

Page 20, Table 4: I feel the comparison between simulated and observed can be better shown with a chart instead of a table

Page 20, lines 8-10: I thought the PFT used here is tropical evergreen instead of tropical deciduous

Page 24, Line 14-15: foliar P concentration is much more variable than N concentration, could it be due to that the pre-defined foliage P concentration range is too narrow?